

APPLICATION  
FOR  
UNITED STATES OF AMERICA

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SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

Be it known that I,

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have invented certain improvements in

“SYSTEM FOR PERFORMING INDUCED LIMB MOVEMENTS,  
PARTICULARLY FOR REHABILITATING AND SPORTS  
PURPOSES”

of which the following description in connection with the accompanying drawings is a specification, like reference characters on the drawings indicating like parts in the several figures.

The present invention relates to a system for performing induced limb movements, particularly for rehabilitating, sports-related and similar purposes. More particularly, the invention relates to a system for the guided execution of limb movements on the part of a patient, particularly for  
5 rehabilitating, sports-related and similar purposes.

### **Background of the Invention**

As is known, the neuromuscular system of a person is meant to coordinate all the motor functions that a person can perform under the control of the brain.

10 In case of traumatic or circulatory or degenerative events, if there has been a partial and/or momentary interruption of the neuromuscular pathways, the coordination of movements, i.e., the pulses that the brain sends to the nerves by means of the neurons in order to make the person perform movements ordered by the brain, may be damaged, and therefore  
15 the patient must undergo rehabilitating treatments in order to require the motor control he has lost.

For this purpose, particular rehabilitation techniques are used in which the patient must perform, with the injured limb, a particular movement, which is traced on the surface; i.e., the patient must follow, with  
20 his limb, as much as possible, a preset path.

However, these techniques, which allow to rehabilitate muscle and tendon proprioception sensors, i.e., the sensors meant to detect the quality and quantity of musculo-skeletal contraction/elongation, and somesthetic sensors, i.e., the sensors meant to detect the position of the various segments  
25 of the limb, are affected by drawbacks.

First of all, physicians or physiotherapists have an objective difficulty in acquiring the data arriving from the patient, i.e., in tracking the progress gradually made by the patient, since the movement that the patient must perform is usually traced on a surface and therefore a trace of the  
30 movements that the patient has performed does not remain in each instance

and it is not possible to compare the path that the patient should have followed with the injured limb and the path that he has actually followed, so as to constantly monitor the improvement and/or deterioration that the patient undergoes during therapy.

5        Moreover, the use of predefined paths, traced on the surface, without any external aid, does not allow to perform the type of therapy in which the patient is ordered to follow a path by applying a certain pressure with the limb in following said path.

10        The pressure is particularly important, since applying it trains not only the somesthetic sensors but also the muscle and tendon proprioception sensors, which detect the quality and quantity of muscle contraction or elongation.

15        The foregoing applies both to the case of rehabilitation therapies and to the case of the use of the previously cited techniques for sports- and fitness-related purposes in general.

### **Summary of the invention**

20        The aim of the present invention is to provide a system for performing induced limb movements, particularly for rehabilitating, sports and similar purposes, which allows the patient to perform a given work, without the mandatory presence of an operator who submits to the patient the various types of path that he must trace with the injured limb or limbs.

25        Within this aim, an object of the present invention is to provide a system for performing induced limb movements that allows the patient to work uninterruptedly, with a preset progression of the difficulty of the movements.

Another object of the present invention is to provide a system for performing induced limb movements that allows to have a substantially infinite plurality of different work programs available for the patient.

30        Another object of the present invention is to provide a system for performing induced limb movements that allows the patient to perform work

that is repeatable over time and whose outcome can be verified by an operator.

Another object of the present invention is to provide a system for performing induced limb movements that is highly reliable, relatively  
5 simple to provide, and at competitive costs.

This aim and these and other objects that will become better apparent hereinafter are achieved by a system for performing induced limb movements, particularly for rehabilitating, sports-related and similar purposes, characterized in that it comprises a central processing unit, at least  
10 one peripheral unit that is adapted to be used by a patient in order to reproduce a rehabilitation path displayed by said processing means, said peripheral unit being provided with position sensors that are adapted to transmit position signals to said processing unit in order to reconstruct the path traced by the patient on said processing unit.

#### 15 **Brief description of the drawings**

Further characteristics and advantages of the invention will become better apparent from the description of preferred but not exclusive embodiments of the system according to the present invention, illustrated by way of non-limiting example in the accompanying drawings, wherein:

20 Figure 1 is a block diagram of the system according to the present invention;

Figure 2 is a view of the system according to the present invention, applied to a non-flat surface; and

Figure 3 is a side view of the device.

#### 25 **Description of the preferred embodiments**

With reference to the figures cited above, the system according to the present invention, generally designated by the reference numeral 1, comprises data processing means, which are conveniently constituted for example by a personal computer 2 provided with display means 3, which  
30 allow to display a plurality of paths, which are programmed in the personal

computer 2 and which the patient must follow with the injured limb or limbs that he accordingly wishes to rehabilitate or exercise.

Conveniently, the patient is provided with means adapted to reproduce on any surface a path that is displayed on the display means 3 of the personal computer 2. Said means adapted to reproduce said preset path are conveniently constituted by a peripheral unit or terminal 4, which is adapted to communicate with the personal computer 2, for example by means of an infrared port, and is provided with position sensors 5, which allow to send to the personal computer signals that are adapted to identify at each instant the position of the peripheral unit 4 on a given surface 6 on which the patient moves the peripheral unit 4 in order to reproduce a path that is displayed on the display means 3 of the personal computer 2.

Substantially, if the injured limb is an upper limb, the patient grips the peripheral unit 4, or otherwise, if the injured limb is one of the lower limbs, he rests his foot on the peripheral unit 4, and moves it on the surface 6, which can be either flat or three-dimensional, as shown for example in Figure 2, and tries to produce the path displayed on the display means 3, by appropriately moving the affected limb.

The peripheral unit 4 constantly sends to the personal computer 2 signals that indicate the position of the peripheral unit 4 with respect to the surface 6, so as to display on the display means 3 the path that the patient is actually tracing on the surface 6, in order to be able to then compare it with the predefined path displayed on the display means 3.

The match, or lack thereof, or the offset, between the predefined path that the patient must try to reproduce and the path actually produced by the patient gives the operator an indication of the capabilities and of the health status of the patient in relation to the affected limb.

Conveniently, the personal computer 2 is provided with means that are adapted to process the path traced by the patient and to make a comparison between said path and the predefined path displayed by the

display means 3, and to produce a result that indicates the degree of match, or lack thereof, between the two paths.

Advantageously, the peripheral unit 4 can be provided with pressure sensors 7, which are adapted to detect the pressure that the user applies to the peripheral unit 4, as a consequence of a given command issued by the  
5 the peripheral unit 4, as a consequence of a given command issued by the rehabilitation program set on the personal computer 2, and to transmit said pressure data item to the personal computer 2, which is provided with means that are adapted to constantly compare the pressure value read by the pressure sensors 7 with the pressure value that the rehabilitation program  
10 expects the patient to apply to the peripheral unit 4.

Conveniently, the connection between the peripheral unit 4 and the processing means constituted by the personal computer 2 may occur not only by means of an infrared port but also by means of any other type of connection, such as cable, wireless and the like.

15 Conveniently, a plurality of peripheral units 4, for example two, may be provided so that the patient performs a bilateral movement simultaneously for particular rehabilitation requirements.

In practice it has been observed that the system according to the present invention fully achieves the intended aim and objects, since it allows  
20 a patient to perform induced limb movements by using peripheral units 4 that are remotely connected to processing means and allow to propose a plurality of different rehabilitation paths, without requiring the presence of an operator in order to modify the path to be submitted to the patient, and especially with the possibility to provide repeatable work that can be  
25 verified by the operator, so as to assess the improvements performed in each instance by the patient.

The system thus conceived is susceptible of numerous modifications and variations, all of which are within the scope of the same inventive concept; all the details may further be replaced with other technically  
30 equivalent elements.

In practice, the materials used, as well as the contingent shapes and dimensions, may be any according to requirements and to the background art.

The disclosures in Italian Patent Application no. MI2003A002126,  
5 from which this application claims priority, are incorporated herein by reference.